Nuclear Weapon Systems Sustainment Programs

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Office of the Secretary of Defense

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PREFACE

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Since the end of the Cold War, the Defense Department's nuclear forces and programs have been refocused and reconfigured to respond to new requirements. The proliferation of nuclear and other weapons of mass destruction is not a hypothetical threat. A number of nation states already have such weapons; a larger number are capable of producing such weapons, potentially on short notice. In future confrontations, the United States may not be the sole decider of nuclear use.

In the National Security Strategy of the United States,(go to footnote *) the President has defined the key tasks that must be accomplished:

- Maintain robust strategic nuclear forces.
- Retain the capability to respond forcefully and effectively and, where appropriate, overwhelmingly, against those who might contemplate the use of weapons of mass destruction so that the costs of such use will be seen as outweighing the gains.
- Develop improved defensive and offensive capabilities. To minimize the impact of proliferation of weapons of mass destruction on our interests, we will need the capability not only to deter their use against either ourselves or our allies and friends but also to successfully operate through WMD use and also, where necessary and feasible, to prevent it.

The Nuclear Posture Review, approved by the President in September, 1994, developed a new strategic nuclear posture responsive to these requirements.

Nuclear Weapon Systems Sustainment Programs are not a new mission for the Department of Defense. The Defense Department has successfully accomplished such sustainment for a half century. At the same time, the department recognizes that adjustments to existing programs and new initiatives are warranted to respond to new circumstances impacting accomplishment of the DoD nuclear mission. Actions that have been taken to underwrite the effectiveness of the new DoD nuclear force posture are outlined in this report.

While significant activities are underway, the Defense Department recognizes that it must accomplish sustainment in a new environment in which no new nuclear delivery systems are under development and there is not an ongoing nuclear test program. The Department of Defense has limited experience in this new environment. Accordingly, this report identifies areas in which consideration is being given to additional initiatives.

Stewardship of national nuclear capabilities is a responsibility shared by the Department of Energy and the Department of Defense. The two departments are working together to meet national needs; action will be taken to foster and increase this collaboration.

/signed/
William S. Cohen

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INTRODUCTION

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This report summarizes the activities that develop and maintain the core competencies, technical and operational, needed for accomplishment of the Defense Department's nuclear missions. It responds to issues regarding the Defense Department's core nuclear competencies raised in recent Senate Armed Services Committee and House National Security Committee reports.

The Senate Armed Services Committee Report on the National Defense Authorization Act for Fiscal Year 1997 expresses concern about *"the ability of the Department of Defense (DoD) to maintain the core competencies of expertise necessary to sustain its nuclear forces in the absence of nuclear testing in the foreseeable future**(go to footnote **)*". It goes on to state that *"The safety, security and reliability of all nuclear weapons systems, to include the delivery system and the related command and control and other associated subsystems, is the responsibility of the Department of Defense."* It notes that *"In order for the DoD to ensure the safety and reliability of its nuclear forces, its military and civilian personnel must maintain their nuclear expertise and core competencies* *(go to footnote **)**"*. Echoing these concerns, the House National Security Committee Report *"recommends that the Department take additional steps to sustain nuclear expertise within the military and civilian personnel of the Department*". The House Report also noted that *"Immediate action should be taken by the Department to establish attractive career paths, including formal education and training, in the services and DoD civilian workforce to insure that the future nuclear deterrent can be responsibly supported."* *(go to footnote ***)*

The Senate Armed Services Committee requested the Department of Defense to submit a report on *"potential initiatives to retain core competencies that would involve developing key science and technology programs; potential opportunities for conducting cooperative training programs between educational institutions, industry, the Defense Nuclear Weapons School, the national laboratories and the military services; and potential career paths for entry level engineers and scientists and the funding necessary to sustain a program of this nature*"*. This report specifically responds to the Senate Armed Services Committee request, but also addresses issues raised in both the House and Senate Reports.

BACKGROUND

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STRATEGIC REQUIREMENTS

In his March 1996 Annual Report to the President and the Congress, Secretary of Defense William J.

Perry noted that:

> *"Although emphasis has shifted in the post-Cold War period from global, possibly nuclear war to regional conflicts, strategic nuclear deterrence remains a key U.S. military priority. The mission of U.S. strategic nuclear forces is to deter attacks on the United States or its allies and to convince potential adversaries that seeking nuclear advantage would be futile. To do this, the United States must maintain nuclear forces of sufficient size and capability to hold at risk a broad range of assets valued by potentially hostile foreign nations. The two basic requirements that guide U.S. planning for strategic nuclear forces therefore are: the need to provide an effective deterrent while conforming to treaty-imposed arms limitations, and the need to be able to reconstitute adequate additional forces in a timely manner if conditions require."*

Under Secretary Walter Slocombe recently reiterated these points in his testimony before the International Security, Proliferation and Federal Services Subcommittee of the Senate Governmental Affairs Committee on February 12, 1997, noting that :

> *"For the foreseeable future, we will continue to need a reliable and flexible nuclear deterrent, survivable against the most aggressive attack, under highly confident constitutional command and control, and assured in its safety against both accidental and unauthorized use. We need such a force because nuclear deterrence, far from being made wholly obsolete, remains an essential, ultimate assurance against the gravest of threats. A key conclusion of the administration's national security strategy, released just a year ago, is that 'The United States will retain a triad of strategic nuclear forces sufficient to deter any future hostile foreign leadership with access to strategic nuclear forces from acting against our vital interests, and to convince [him] that seeking a nuclear advantage would be futile. Therefore, we will continue to maintain nuclear forces of sufficient size and capability to hold at risk a broad range of assets valued by such political leaders."*

At the conclusion of the Cold War, the Defense Department accomplished a comprehensive appraisal of nuclear mission requirements and of the nuclear force structure responsive to these needs. This encompassed post-Cold War military requirements and arms control and other political-military considerations. Results from this DoD Nuclear Posture Review (NPR) were endorsed by the President in 1994.

The key parameters for DoD Nuclear Weapon Systems Sustainment Programs are provided by the NPR objectives and posture approved by the President, and by concurrent requirements to ensure the continued effectiveness of DoD forces and systems that must be able to withstand any threats posed by nuclear-armed antagonists during regional contingencies.(go to footnote ****)

STRATEGIC FORCE REDIRECTION

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Consistent with the NPR, significant reductions in numbers of strategic delivery systems and deployed nuclear weapons are anticipated. Table 1 depicts the anticipated evolution of the nuclear force structure from levels at the conclusion of the Cold War (1989) through the first years of the next century, by which START II will hopefully be implemented. Reductions are significant, e.g., the number of ICBMs will be cut in half, and the number of ICBM warheads will be reduced by 80%.

For the first time in the half century over which the Defense Department has accomplished Nuclear Weapon Systems Sustainment Programs, no new strategic delivery systems are in development. Plans call for retention of a reconfigured subset of existing strategic delivery systems in the force structure for an extended period of time, well-beyond the originally programmed service lives of these systems. Concurrently, the Department of Energy has no new nuclear weapons under development, with the plan being to retain existing devices in the deployed posture for periods that exceed initially programmed service lives.

In a period of DoD reconfiguration to respond to new, post-Cold-War requirements there have been significant reductions in DoD spending on strategic offensive forces. As outlined in Figures 1 and 2, spending on strategic offensive forces is at less than one-half of the Cold War level; concurrently, the percentage of total DoD spending invested in these capabilities has declined.

Planning assumes that there will be no underground nuclear testing in the foreseeable future. This impacts DoD activities to validate the survivability of systems and forces as well as DOE warhead development and sustainment programs.

Table 1

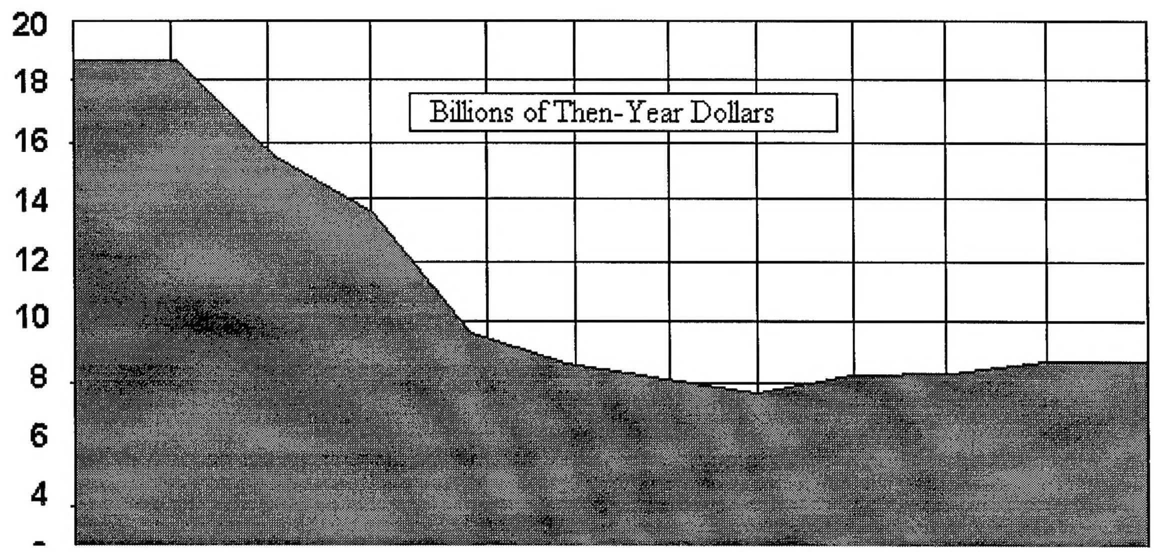
Reduction in U.S. Strategic Nuclear Arsenal FY 1990, FY 1997, FY 2003

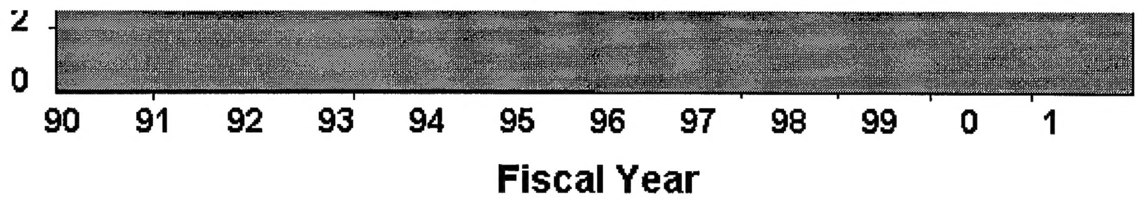
			FY 2003	
	FY 1990	FY 1997	START I	START II
ICBMs	1,000	580	550	500
Declared Warheads on ICBMs	2,450	2,090	Not over 2,000	500
SLBMs	568[a]	432	432	336
Declared Warheads on SLBMs	4,864[a]	3,456	Not over 3,456	Not over 1,750
Ballistic-Missile Submarines	31[a]	18	18	14
Declared Warheads on Ballistic Missiles	7,314[a]	5,546	Not over 4,900	Not over 2,250
Heavy Bombers (PMAI/TAI)	282/324[b]	102/202	60/92[c]	60/92[c]

Note: PMAI = Primary Mission Aircraft Inventory; TAI = Total Aircraft Inventory
[a] Excludes five decommissioned submarines (and their associated missiles and warheads) that were still START accountable.
[b] Excludes FB-111s.
[c] Excludes 95 B-1s that will be devoted entirely to conventional missions.

Figure 1

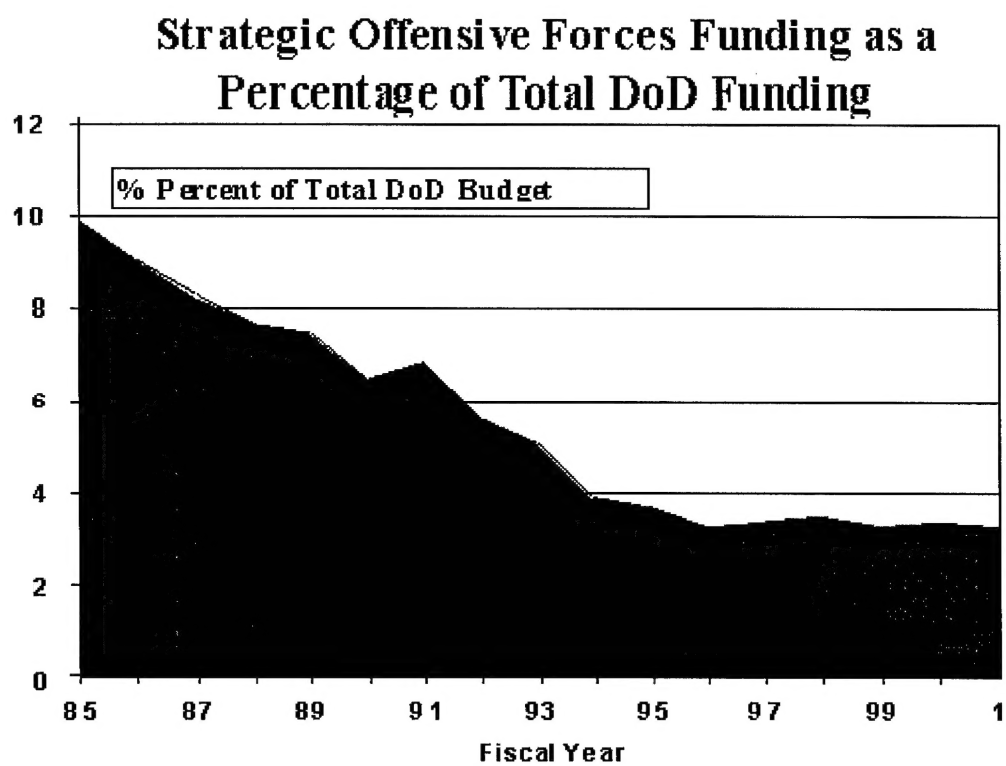
Strategic Offensive Forces Funding





Secretary of Defense Annual Report to the President and the Congress March 1996, p. 216

Figure 2



Secretary of Defense Annual Report to the President and Congress, March 1996, p. 217

NUCLEAR SUSTAINMENT RESPONSIBILITIES

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Public law, notably the Atomic Energy Acts of 1946 and 1954, as amended, assigns responsibilities for national nuclear capabilities to the Department of Energy (DOE) and the Department of Defense (DoD). DOE has responsibility for the design, production, and end-of-service-life disposition of nuclear warheads. DoD is responsible for the other facets of national nuclear capability, including definition of military requirements for warheads, delivery systems, operational deployment of forces, and the ensemble of end-to-end capabilities needed for the planning and conduct of operations by nuclear forces. Stated in simpler terms, DOE provides stewardship for nuclear warheads; DoD is responsible for everything else.

National decisions that resulted in the termination of nuclear testing and the end of development work on

new nuclear weapons have had far-reaching impact on DOE weapon programs. As outlined in Appendix A, the Department of Energy has responded by developing a completely new approach for accomplishment of its nuclear stewardship responsibilities. These efforts are based on a comprehensive Stockpile Stewardship and Management Program (SSMP).

DoD has increased its cooperation with DOE for nuclear-weapons-related matters. This includes Defense Department participation in significant new programs, such as Dual-Revalidation of the nuclear stockpile. DoD is closely monitoring technical activities within DOE that provide potential lessons learned for application in Defense Department programs, e.g., technologies for enhanced surveillance of aging materials and components.

In addition to its responsibilities and functions as the provider of national nuclear weapon systems capabilities, the Defense Department must also support national strategy by being an informed customer for the nuclear stockpile product produced and sustained by the Department of Energy, and by being a capable, effective partner in cooperative activities with DOE.

As the course of sustainment activities within the two departments progresses, additional initiatives may be warranted. In the past, much of the needed cooperation was accomplished on a weapon-system-specific basis; such activity continues for the weapons and systems comprising the nuclear stockpile and force structure. As the Department of Energy makes progress in SSMP implementation, Defense Department nuclear activities and procedures can and will be adapted to ensure that DoD has an appropriate interface with the DOE program. Specifics necessarily depend on the course of activities within both departments.

For example, in its SSMP effort the Department of Energy is developing new experimental and computational capabilities to provide the enhanced predictive capabilities needed to assess the complex problems associated with an aging stockpile and to redress important shortfalls in our fundamental understanding of nuclear weapon physics. There must be corresponding improvements in DoD experimental and computational capabilities to support cooperation with DOE on stockpile confidence activities and to ensure that Defense Department nuclear weapon effects programs are based on the best possible understanding of fundamental weapon physics, and to allow DoD to take advantage of new technical capabilities developed by DOE that are relevant to the Defense Department's nuclear mission.

PATHWAY TO NUCLEAR SUSTAINMENT

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Nuclear Weapon Systems Sustainment Programs are not a new mission for the Department of Defense. DoD has accomplished such programs for more than 50 years. Some important lessons can be learned from past successes. A prominent success story involves the successive improvements that have allowed the B-52 strategic bomber to be an effective nuclear delivery system from its introduction in the 1950s through the 1990s. A number of critical factors have been identified.

The B-52 strategic bomber was a priority program during the Cold War, when the nuclear deterrence mission was at the top of the Defense Department's agenda. Effective strategic bombers were a "must have" capability.

Because the B-52 was a priority, associated career paths existed for large numbers of military and civilian personnel. It was literally possible to spend a career working with or on this aircraft.

The B-52 was an active program. While the scale of activity has varied, technical effort to support modernization has been continuous from development of the A series in the 1950s through sustainment of currently deployed H series aircraft. There was concurrent large-scale operational activity. This was critical because the best way in which to validate the accomplishment of sustainment is through the demonstrations provided in stressing, realistic exercises.

The B-52 program involved continuous modernization over a course of decades. Engines were replaced

with new models. Avionics and other electronics were updated or replaced with more modern technologies. Aircraft were under constant surveillance. Everything was managed as a limited life component that would be (and was) replaced at some point.

Due to its size, the B-52 was a robust program. If 50 officers elected to take early retirement or pursue other career paths, there were many candidates for these positions. If a major subcontractor went out of business, other firms were available to take on new work.

Based on these and other experiences in sustaining operational and technical military capabilities, some general principles can be identified. These considerations have influenced the Defense Department's planning for Nuclear Weapon Systems Sustainment Programs.

Sustainment is most likely to be successfully accomplished for nuclear systems or other military capabilities when and if a set of interrelated conditions are achieved:

- The capability is clearly and consistently given priority by the department's senior leaders.
- All of the physical components that make up the capability are regarded as limited-life parts that require constant surveillance and are refurbished, modernized, or replaced as needed.
- Career paths exist for both military and civilian personnel that attract and retain sufficient numbers of personnel with appropriate qualifications.
- The program involves a complete, end-to-end (development-deployment-operations) capability and also involves a high level of particularly realistic, stressing exercises to validate that capability has been sustained.
- The potential for modifying existing weapons/weapon systems (without nuclear weapons testing) to meet plausible future contingencies is maintained.
- The magnitude of the activity is sufficient to support achievement of the preceding conditions.

Sustainment will be a DoD mission for the foreseeable future. While the composition of the nuclear force structure and stockpile will necessarily impact activities, so long as one weapon and delivery system remain in our force structure, action will have to be taken to ensure that DoD nuclear weapon systems are effective, safe, secure, reliable, and survivable.

Some activities can and have been scaled to the size of the nuclear force structure; as the number of weapons in the active stockpile has declined, there have been corresponding cut-backs in numbers of weapon inspection personnel. Many key activities, however, do not scale, one-to-one, with the size of the nuclear force structure.

While there is considerable continuity in Defense Department Nuclear Weapon Systems Sustainment Programs, there are also significant new considerations which have prompted initiatives summarized in this report. Key developments include:

- Refocusing from the peer competition threats associated with the Cold War strategic confrontation to the risks and hazards associated with proliferant threats.
- Termination of nuclear testing and development of alternative methods for validating nuclear capabilities.
- The decision to retain a subset of existing systems and weapons in the force structure for periods beyond original service lives, and the decision not to build new systems.
- A strategic environment in which nuclear deterrent capabilities will continue to be important, but not receive the high level of emphasis prevalent during the Cold War.

DOD NUCLEAR WEAPON SYSTEMS SUSTAINMENT PROGRAMS

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INTRODUCTION

This section provides an overview of DoD programs to sustain nuclear weapons systems. These programs are being accomplished in accordance with standard Defense Department management practices, which involve centralized policy and requirements development and decentralized program execution by DoD Components. Information concerning the officials and organizations involved in these programs is provided in Annex B.

Interdependent program activities are summarized under a number of headings; special priority is given to measures to ensure that sufficient numbers of competent personnel (operational and technical) are available to support DoD Nuclear Weapon Systems Sustainment Programs:

- Maintaining Nuclear Skills
  - Organizations and Procedures
  - Ensuring that Sufficient Numbers of Qualified Personnel Support DoD Nuclear Weapon Systems Sustainment
  - Nuclear Education
  - Operational Training
  - Exercises
  - Radiological Incident and Accident Response
  - Cooperation with the Department of Energy
  - The Alliance Program
- Weapon System Hardware Technology
  - OSD, Joint, and Interagency Programs
  - Navy Programs
  - Air Force Programs
- Nuclear Effects Phenomenology and Hardening Technology
  - Status of Requirements
  - Nuclear Effects, Weapon-Target-Interactions, and Hardening R&D
  - Defense Radiological/Biomedical Research
  - Computational and Simulation Programs
  - Weapon Effects Simulators
  - Additional Initiatives
- Preservation and Application of the Defense Department's Nuclear Weapon Effects Knowledge

MAINTAINING NUCLEAR SKILLS

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Organizations and Procedures

At the conclusion of the Cold War, there were both Department-wide and Component-specific appraisals of organizations and procedures' suitability for accomplishment of Nuclear Weapon Systems Sustainment Programs and other tasks, given new missions, force structure, and circumstances. It was concluded that existing organizations and procedures could be adapted to respond to new needs. This has involved establishment of new focal points, e.g., the Air Force has established a Director for Nuclear and

Counterproliferation on the Air Staff to provide oversight for nuclear matters. It has entailed consolidation of operational activities, e.g., the transfer of some nuclear training programs to the Defense Nuclear Weapons School. It has involved the consolidation of DoD nuclear effects-related science and technology activities within the Defense Special Weapons Agency (DSWA).

Ensuring That Sufficient Numbers of Qualified Personnel Support DoD Nuclear Weapon Systems Sustainment

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CONSIDERATIONS The Defense Department's objective is to ensure that sufficient numbers of qualified personnel, military and civilian, are available to support accomplishment of nuclear weapon systems-related missions. In the past, this was not a primary concern. Nuclear missions had priority within the department; with significant numbers of new systems in development, the industrial base supporting these missions did not require conscious management by the Defense Department.

In contrast, even during the Cold War DOE had a more challenging set of industrial base issues to address. Many of the DOE facilities involved in weapons production focused on activities that were unique to the mission. Production of plutonium pits for nuclear weapons does not have a counterpart civilian industry. Absent conscious management, there wouldn't be an industrial base to support DOE nuclear weapons programs. The Stockpile Stewardship and Management Program outlined previously is the Department of Energy's redirection of its programmatic and technical strategy to address new requirements.

The Defense Department's situation today is very different from that during the Cold War. No new delivery systems are under development; significant downsizing has occurred.

Several points have been given attention in initial Defense Department appraisals of the availability of sufficient numbers of qualified personnel:

- This is a transitional period; with significant downsizing, more personnel are potentially available than would normally be the case, given the size and character of the market for their specialized skills. However, preliminary indications from portions of the industrial base give cause for concern. An informal survey of some major DSWA contractors found that, over the past five years these firms have hired almost no new junior technical personnel. While senior staff are still available and are working on current requirements, their replacements are not coming on board and being trained.

- Appraisals of options for acquiring, assigning, and retaining sufficient numbers of personnel with requisite qualifications should not be unnecessarily constrained by past approaches. For example, if past practice was to assign officers with technical degrees to perform certain functions and insufficient numbers of qualified officers are now available, a number of options, including use of civilian government personnel to perform the function and contracting with industry, also need to be given consideration. If the only solution is to have officers perform the function, DoD will fund graduate study by military personnel or otherwise meet the requirement, but it must be a revalidated requirement.

- In accordance with DoD acquisition reform, maximum possible reliance is being placed on dual-use technology development, to include adaptation and adoption of civilian products and services. DoD can't afford to reinvent what is already available or to constitute and maintain teams that duplicate expertise available in the private sector, or to insist on military-specification (Mil-Spec) versions of every hardware component in the arsenal. DoD would be foolish to attempt to replicate best-in-world technical capabilities that are already available commercially as long as these capabilities can survive and perform in a military environment with potential use of weapons of mass destruction.

- The department has limited experience in this new environment. The data base is insufficient to support development of a firm set of conclusions and recommendations.

NAVY TEAM CONCEPT. In this initiative to preclude potential shortfalls in the availability of sufficient numbers of qualified personnel, the Navy's Strategic Systems Program (SSP) office has adopted the objective of maintaining an integrated team of DoD and DOE government and contractor organizations. This team is managed by SSP headquarters and includes support from Navy shore facilities such as the Strategic Weapons Facility Atlantic (SWFLANT) and Strategic Weapons Facility Pacific (SWFPAC), and SSP program management offices at all the major hardware contractors, such as missile and re-entry system developers. The DOE members of the team include DOE Headquarters and DOE/Albuquerque Operations supported by Los Alamos National Laboratory (LANL) and Sandia National Laboratories (SNL), plus Lawrence Livermore National Laboratory (LLNL) for selected programs.

The Navy SSP team has responsibility for all SLBM weapon systems from initial concept through development, deployment, and retirement. It has consistently supported all systems, ensuring continuity, smooth integration of efforts, and preservation of the knowledge base. A primary objective is to avoid duplication while using the strengths of each member. Competition among team members is minimized. The team has been substantially intact across all SLBM weapon systems with little change, allowing maintenance of technologies, expertise, and working relationships.

In addition to programs previously mentioned, the Navy SSP team is also maintaining its expertise in strategic submarine navigation by exploring the submarine navigation center of the future. This program is taking advantage of commercial and non-developmental items for cost savings and integrating them with application-specific items into packages which can withstand the submarine environment.

Other Components will be encouraged to adopt this or other innovative approaches as potential critical shortfalls in personnel numbers, skills, and career paths are identified.

Nuclear Education

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NUCLEAR ENGINEERING PROGRAMS A number of activities critical to Nuclear Weapon Systems Sustainment Programs require nuclear engineers with graduate qualifications. Developments in the civilian nuclear power industry have resulted in the downsizing or closing of such graduate programs. While the situation needs to be monitored, developments have not yet reached the point where they are likely to have a negative impact on DoD.

MILITARY SERVICE AND DEPARTMENT PROGRAMS. There have been cutbacks in the specialized technical programs conducted by the Services. The Air Force has eliminated its graduate degree program in nuclear engineering at the Air Force Institute of Technology (AFIT). With the declining interest in nuclear weapons research at the Air Force Phillips Laboratory, the Air Force Technical Applications Center (AFTAC) and the Air Force Safety Center (AFSC) are the only organizations with stated requirements for AFIT nuclear graduates, although the Army and DSWA use AFIT graduates to fill certain billets.

The Naval Postgraduate School (NPG) continues to offer courses in the physics of nuclear weapons, nuclear weapons effects and nuclear warfare analysis; the number of students is typically 4-5 per course. However, no students elected to take the nuclear warfare analysis course last year.

The Navy has established an intern program for recent engineering graduates. The program is designed to take recent graduates and assign them to an SSP Field Activity or an SSP contractor facility to learn the various aspects of the design, maintenance, logistics support, and operational use of the fleet ballistic missile system. At the completion of their internship, these individuals will be assigned to SSP headquarters with a full scope of understanding of the mission and function of the SSP organization. To

date, the program has had limited success in attracting qualified candidates. The main reason given by graduates is not just the salary but the inability to perform new and rewarding work on advancing technology and the lack of facilities to apply their education.

Additionally, six to ten Army Nuclear Research and Operations Officers enter advanced degree programs in nuclear-related fields annually. This number includes Army officers at the Air Force Institute of Technology (AFIT) and Naval Postgraduate School (NPG), as well as instructor candidates for West Point's Department of Physics. The Army also maintains a short course that certifies all Army nuclear officers for jobs in nuclear research and operations within Defense, Joint, and Army agencies. Approximately 20-25 Army officers have attended this course in recent years. In another activity, the Army sends officers to a revised nuclear targeting course currently taught at Fort Sill and Fort McClellan. Completion of this course confers a formal Additional Skills Indicator (ASI) on the officer. Most attendees are chemical or field artillery officers. All chemical officers receive this training during their Officer Advanced Course. Plans call for this course to transition to the Defense Nuclear Weapons School (DNWS).

THE DEFENSE NUCLEAR WEAPONS SCHOOL (DNWS). DNWS is a joint service organization providing training in nuclear capabilities, nuclear weapon accident response, counterproliferation awareness and environmental remediation. DNWS provides training and education vital to sustaining the special weapons knowledge base for the DoD, federal, state, local, and allied personnel by:

- Developing and implementing a curriculum to support national nuclear capabilities;
- Providing education and training in all aspects of nuclear weapon accident response and site restoration;
- Conducting courses dealing with proliferation threats and response options.
- Supporting DoD, federal, state, and local agencies as the Center of Excellence for special weapons education and training information;
- Operating the only radioactive training sites in the DoD for nuclear weapons accident education and training programs; and
- Maintaining the largest and most complete classified weapons display area.

DSWA assumed management responsibility for the school from the Air Force in 1993 . Since then, DSWA has expanded the School's mission, initiated renovation of the facility and weapons display area, trebled the course offerings from 5 to 16 (six new courses were added during fiscal year 1996 alone), established the Office of Academic Dean, appointed an experienced nuclear effects test engineer to that position, and introduced multimedia technology.

Operational Training

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As the Defense Department has reconfigured and downsized to adapt to new requirements, efficiencies have been realized by centralizing training. This has included expansion of operational training programs at the Defense Nuclear Weapons School. Two additional courses responding to Service needs, including a Nuclear Crewmember Course for missile and bomber crews, are planned for this fiscal year and an additional six courses are anticipated by the end of the decade. DNWS will begin teaching a Joint Theater Nuclear Targeting Course this year. This course will use recently approved joint doctrine as its basis. A new joint DSWA-Sandia course in nuclear explosive ordnance disposal (EOD) will be offered this year under the Alliance sponsorship described later in this report.

In March 1996, the U.S. Strategic Command (USSTRATCOM) requested that DSWA provide support

for nuclear targeting training. This requirement arose due to the elimination of DoD formal training in strategic nuclear planning, the elimination of the Air Force's target intelligence career field, and the decline in the number of trained targeting personnel. Training modules were delivered to USSTRATCOM on 4 December 1996 and DSWA will provide periodic, independent analyses of the training, as requested.

DSWA has also responded to CINC and Service requests by developing short courses on nuclear weapons effects related topics that are presented at Unified Command and Service facilities. A course on the military effects of nuclear-weapon-produced High Altitude Electromagnetic Pulse (HEMP) was recently given at both U.S. Space Command (USSPACECOM) and USSTRATCOM.

Exercises

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Realistic exercises are essential for sustainment of DoD Components' ability to accomplish nuclear operational missions. Stressing, realistic exercises are the best ways in which to demonstrate and revalidate operational capability. As illustrated in the examples presented in Figure 1, U.S. Strategic Command, which is responsible for the preponderance of U.S. nuclear forces, has a vigorous nuclear exercise program. Regional Unified Combatant Commands with nuclear responsibilities also have exercise programs which are accomplished both independently and in coordination with U.S. Strategic Command.

The North Atlantic Treaty Organization (NATO) has adapted its planning and exercise activities so that they respond to current day mission needs. The Defense Special Weapons Agency has assisted NATO planners by developing and transferring automated systems to support these activities.

Figure 3

EXAMPLES OF U.S. STRATEGIC COMMAND NUCLEAR EXERCISE ACTIVITIES

GLOBAL GUARDIAN

Annual command-level exercise sponsored by the U.S. Strategic Command in cooperation with Space Command and the North American Aerospace Defense Command.

The primary purpose of the exercise is to test and validate nuclear command and control and execution procedures. Exercise objectives include live communications and the participation of all elements potentially assigned to USSTRATCOM in wartime, including USSTRATCOM's Mobile Consolidated Command Center (MCCC), USSTRATCOM's Airborne Command Post (ABNCP), and external participation from national-level and other unified commands.

The exercise links with other exercise activities sponsored by the Chairman, Joint Chiefs of Staff and the Unified Commands, to include:

- CROWN VIGILANCE, sponsored by the Air Combat Command.
- APOLLO GUARDIAN, sponsored by Space Command.
- AMALGAM WARRIOR and VIGILANT GUARDIAN, sponsored by the North American Aerospace Defense Command

GLOBAL ARCHER

Periodic exercises conducted by U.S. Strategic Command. These exercises are designed as training events to validate and test battle staff, transition to war, and adaptive planning procedures. Activities can involve simulated trans- and post-execution operations utilizing U.S. Strategic Command's Mobile Consolidated Command Center and Airborne Command Post.

Some GLOBAL ARCHER exercises link, when appropriate, to exercises sponsored by Chairman, Joint Chiefs of Staff and other Unified Commands, e.g.,
APOLLO GUARDIAN, sponsored by Space Command.
VIGILANT GUARDIAN, sponsored by the North American Aerospace Defense Command
POSITIVE FORCE, sponsored by Chairman, Joint Chiefs of Staff
CROWN VIGILANCE, sponsored by the Air Combat Command

EXERCISES SPONSORED BY OTHER COMMANDS

U.S. Strategic Command participates in exercises involving consideration of, or planning for, strategic strike options, or in which U.S. Strategic Command elements are needed to support these activities. Such exercises can serve as building blocks for follow-on U.S. Strategic Command-sponsored exercises and/or as evaluation tools. Examples of such exercises with U.S. Strategic Command participation include POSITIVE FORCE, POSITIVE RESPONSE, and senior Service School strategic exercises.

Source: U.S. Strategic Command

The military departments and services also have exercise programs. The U.S. Army's Nuclear and Chemical Agency (USANCA) augments the staffs of Land Component Commanders (LCC) in all exercises involving nuclear employment. These Nuclear Employment Augmentation Teams (NEAT) plan nuclear weapon employment for the LCC during the exercise. In time of hostilities, NEAT teams serve with the LCC staffs. USSTRATCOM performs similar functions for CINC staffs.

Twice a year, Navy selects an attack submarine and conducts a regeneration exercise that demonstrates and appraises the capability to redeploy nuclear-armed cruise missiles on such submarines. This exercise

tests the ability of the submarine and crew to re-establish nuclear weapons capability in a relatively short time.

Cooperation with the Department of Energy

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ASSIGNMENT OF DOD PERSONNEL TO DOE LABS

DSWA has created two officer billets, with 3-year assignments, at each of the nuclear weapons design laboratories to serve as Dual Revalidation Associates. In fiscal year 1996, DSWA assigned two officers each to Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL). Two officers will be assigned to Sandia National Laboratory (SNL) in 1997. Both the Navy and the Air Force assign officers to DSWA for this purpose. This contributes to developing career paths for officers with nuclear weapons qualifications within these Services. Additionally, a small number of Army and Navy officers are assigned for three-year tours at the DOE laboratories as Military Research Associates, providing valuable training for their future assignments. These officers will use their education and training in the processes required to contribute to activities that validate the safety, reliability and performance of nuclear weapons. Following their laboratory tours, these officers are expected to return to nuclear related duties within DoD.

Dual Revalidation. Plans call for some nuclear warheads to remain in the stockpile for periods that extend beyond their originally programmed service lives. Dual Revalidation is a joint DoD/DOE process to recertify the ability of nuclear warheads to continue to meet the safety, performance, and reliability requirements in the Military Characteristics and the normal and hostile environments in the Stockpile-to-Target Sequence documents.

The first warhead to undergo Dual Revalidation is the Navy's W76/MK4 SLBM reentry system. The W76/MK4 Dual Revalidation involves DOE-sponsored weapon laboratories (LANL, LLNL, and SNL) and the Navy Strategic Systems Programs (SSP) government and contractor team. The process is coordinated through the W76/MK4 Project Officers Group and is a multi-year effort with significant modeling and testing activities.

Many of the activities in Dual Revalidation maintain system knowledge to examine aging effects and develop supporting science, technology, and training crucial to maintaining the system in the long-term. Testing includes warhead hydrodynamic tests and magnetic flyer plate vulnerability testing. Complex three-dimensional computer models of physics package (DOE) and the re-entry body structure (DoD) are being exercised and benchmarked against test data from the development program. Critical test data from the development program and other related weapons tests are being recovered and preserved. Lessons learned from the W76/MK4 Dual Revalidation program will have applicability for the dual revalidation of other nuclear weapon types.

The Alliance Program

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In 1994, the Defense Special Weapons Agency initiated informal discussions with other organizations that have nuclear missions and expertise. Government participants have included Air Force Phillips Laboratory and the Department of Energy, which was supported by Los Alamos National Laboratory, Sandia National Laboratory, and Lawrence Livermore National Laboratory have also been included in these discussions.

These interactions have resulted in establishment of an Alliance for Nuclear-Related Defense Technologies, commonly known as the "Alliance". The Alliance's long-term goal is to ensure that the nation retains its core competencies in nuclear-related defense technologies and successfully passes this knowledge base and critical skills to future nuclear defense-oriented scientists, engineers and weapon

system developers. Its more immediate purpose is to provide a forum to discuss and review nuclear-related defense technologies, insure the preservation of knowledge and critical skills, identify the problem areas, propose corrective measures and take cooperative actions as appropriate.

One of the joint projects being considered by the Alliance deals with developing and maintaining critical skills in nuclear weapons-related technologies (NWRT). The Alliance will explore actions to:

(1) Introduce elements of NWRT into undergraduate and graduate curricula at the Service academies and other educational institutions,
(2) Enhance NWRT career development opportunities, and
(3) Develop career enhancement opportunities for military and industrial personnel through cooperative education and training with Defense Nuclear Weapons School and Alliance organizations.

In Fiscal Year 1997, DSWA tasked the RAND Corporation to undertake a 6-month study to develop an implementation plan for this DSWA Critical Skills project. Key elements of the RAND study include: characterizing NWRT critical skills; reviewing supporting programs among Alliance members; identifying applications and underlying technologies suitable for undergraduate and graduate instruction; identifying special roles for military academies and Service schools, including the DNWS; identifying candidate university participants and appropriate academic incentives; and identifying possible partners among government, industry, and academia. Senior representatives of the Alliance organizations will provide inputs to the RAND study. A final report and implementation plan is expected by summer 1997.

As already noted, cooperative efforts have begun in education and training with the development between SNL and DSWA of an enhanced course in explosive ordnance disposal at the Defense Nuclear Weapon School. DSWA is also cooperating with DOE's nuclear weapons information group concerning preservation of nuclear legacy data.

WEAPON SYSTEM HARDWARE TECHNOLOGY

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Introduction

This section describes Nuclear Weapon Systems Sustainment Programs directed at maintaining the ability of hardware systems to meet mission requirements. Activities proceed on the assumption that every element within these systems is a limited-life component that must be monitored and, at some point, refurbished, modernized, or replaced.

The activities addressed below focus on requirements that have been identified to date. It is recognized that additional requirements may develop. For example, given the proliferation of very hard and critical strategic targets, capabilities that do not exist today could be needed. Such new capabilities could be achieved through modification of existing nuclear weapon systems. Several of the disciplines mentioned in this report would be required to adapt existing weapon systems to new targets and missions. Such efforts would also serve to sustain our national capability to understand and apply knowledge and expertise regarding weapon/weapon system properties, survivability, and maintenance.

OSD, Service, and Interagency Programs

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JOINT NAVY/AIR FORCE NUCLEAR WEAPON SYSTEMS SUSTAINMENT PROGRAMS.
In 1994, the U.S. Strategic Command's Strategic Advisory Group recommended initiation of industrial sustainment programs for unique ballistic missile reentry systems and guidance technology applications. The resulting Air Force and Navy programs are coordinated by the Services to preserve critical design expertise and manufacturing capabilities while investigating new technologies for use in existing system

improvements or future system designs. Approximately 90 percent of the resources available to the Navy in these programs flow directly to the industrial base contractors; both programs are fully funded in the five-year defense plan.

Reentry Systems Applications Program (RSAP). This coordinated program supports service life extension for deployed reentry systems and addresses potential future requirements for re-entry systems. The program is structured into four major elements:

- Service life extension assessments which includes age related assessments, predictive methods for determining the effects of aging, and flight testing to assess systems performance.

- Development of replacements for components at risk to age-related performance degradation. Replacement of aft closure installation and heatshield materials along with other long lead items are being evaluated.

- Support for defined re-entry system programs such as the SLBM Warhead Protection Program and system performance assessments.

- Preservation of critical re-entry body development and assessment capabilities including test and fabrication facilities assessments and support, maintaining key engineering skills and calculational capabilities, and providing support to critical vendors.

Since its inception in 1995, RSAP has completed a state of the art survey and industrial base assessment and begun projects to identify replacement heatshield materials and to develop improved flight test instrumentation. In the future, new re-entry body materials and new component designs will be flown in conjunction with other periodic weapons system reliability tests. Nuclear reentry system nuclear hardness design and maintenance are not included in this effort.

Guidance Applications Program. This coordinated effort, which began in 1996, is evaluating new guidance technologies for accelerometers, gyros, and stellar sensors, and will develop open architecture system modeling and simulation capability to assess candidate component designs.

Radiation Hardened (Rad Hard) Microelectronics. This program responds to DoD requirements for microelectronics that can accomplish missions in both natural (space) and weapon-induced radiation environments. The most recent phase in this program began in December 1995, when Director, Defense Research & Engineering presented results from a study of DoD rad hard microelectronics requirements. In response, the Under Secretary of Defense (Acquisition & Technology) (USD(A&T)) established a Radiation Hardened Integrated Product Team (IPT) with department- and government-wide participation. The IPT presented its report to USD(A&T) in December 1996. Primary conclusions and recommendations were that:

- DoD has unique needs for advanced radiation hardened microelectronics.

- Demand for such hardened microelectronics is anticipated to increase.

- While near-term industrial capability is not at risk, DoD funding is not at the level needed to produce the advanced radiation hardened products that will be needed in the near future.

- An increase in funding for development of radiation hardened microelectronics technology is warranted.

- A Rad Hard Oversight Council should be established with DoD and interagency mechanisms to provide oversight for this corporate investment.

- An initiative is warranted to provide a small number of graduate fellowships in engineering fields that contribute to advancement of rad hard microelectronics technology.

USD(A&T) has endorsed the Rad Hard IPT recommendations. Program Objective Memorandum (POM) guidance has been issued directing Components to maintain recommended levels of investment in radiation hardened microelectronics technologies.

Strategic Technology IPT Initiatives. In January 1996, DDR&E established an IPT with department-wide participation to identify potential science and technology efforts with high payoff in facilitating the sustainment of strategic systems. This IPT addressed six of the highest priority sustainment needs identified by U.S. Strategic Command, with emphasis on technology efforts that could impact either 1) the sustainment of existing systems, through the development of more readily available process and product technology for replacement components, and through life monitoring and prediction techniques; or 2) the sustainment of industrial capability, through the development of modeling and simulation tools, and through the development of multi-use technology applicable to both strategic systems and other market areas. The common theme of all of the potential technological solutions is to reduce reliance on unique materials and processes and on unique human-expertise-intensive processes. The six technology programs recommended by the IPT and included in the Fiscal Year 1998 President's Budget Submission are:

> MISSILE SOLID PROPULSION. Goals are to develop a multi-use, less detonable (Class 1.3) propellant that meets all ballistic missile requirements, and to develop the necessary component technology compatible with the new propellant by FY 2004. This will eliminate dependence on the unique, more hazardous propellants in use, for which production capability is diminishing.
>
> MIRV DEPLOYMENT AND CONTROL SYSTEMS. Objectives are to develop and demonstrate SLBM Post Boost Control System (PBCS) technologies using readily available materials by Fiscal Year 2003, and to develop non-permeable materials compatible with the ICBM PBCS environment by Fiscal Year 2002. This will eliminate the current dependence on unique high-temperature (refractory) metals for SLBMs, and reduce concerns over long-term storage of elastomeric materials for ICBMs.
>
> SOLID ROCKET MOTOR AGING AND SURVEILLANCE. Objectives are to extend the ability to predict remaining motor life to 10 years with a 90% confidence level, and to develop techniques that permit individual motor predictions as well as motor population predictions by Fiscal Year 2004. This will maximize the availability of the ballistic missile force by eliminating needless replacement of satisfactory motors and by providing sufficient time to replace unsatisfactory motors.
>
> UNDERWATER LAUNCH SYSTEMS. This thrust develops underwater-launch modeling and simulation tools that permit effective design and analysis of current and future SLBM designs, and develops options for low-cost underwater test facilities by Fiscal Year 2004. This will result in a reduction in underwater-launch expertise required in the future, as well as to provide the availability of economical options for underwater-launch tests in the future.
>
> SUBMARINE NAVIGATION. Objectives are to adapt fiber optic gyroscope technology, and develop associated thermal control to meet SSBN navigation requirements by Fiscal Year 2001, and to develop accelerometer technology suitable for SSBN applications by Fiscal Year 2002. This will eliminate the current dependence on dated components and unique materials, as well as provide a significant reduction in Operations & Maintenance (O&M) costs.
>
> MISSILE FLIGHT SCIENCES. The objectives are to improve and merge science-based design and analysis models for SLBMs and ICBMs by Fiscal Year 2004. This will result in a significant reduction in the amount of individual expertise required for the design and analysis of existing and new systems, as well as a reduction in the resources required to operate the models.

A number of Defense Technology Objectives (DTOs) under DDR&E oversight have been defined for matters being addressed in this IPT process, e.g., DTOs for Materials and Processes for Reentry Vehicle Technology and for Technology for Sustainment of Strategic Systems. This ensures that these activities are given priority and also guarantees high visibility within DoD Science & Technology (S&T)

oversight processes. Consideration is being given to a recommendation from the March 1997 Chemical-Biological & Nuclear Technology Area Review and Assessment to establish a process within the Defense S&T planning and oversight system that provides for integrated review of all Defense Technology Objectives relevant to Nuclear Weapon Systems Sustainment Programs.

Integrated High Payoff Rocket Propulsion Technology (IHPRPT) This is a joint DoD, NASA, and U.S. rocket propulsion industry science and technology initiative which has the objective of doubling the national rocket propulsion capability by the year 2010. This objective is to be met by achieving challenging time phased technology goals which are subscribed to by both the government and rocket propulsion industry. The potential payoffs associated with these goals are strategic, space and tactical rocket propulsion systems which carry at least 50% more payload, cost 50% less to manufacture and maintain, or reduce the dollars to pound to low earth orbit by 60%, as compared to existing systems. This provides the space and weapons system designers an attractive range of rocket propulsion component and system options for new systems or system upgrades.

The technologies being developed under IHPRPT are applicable to strategic, space and tactical systems. The technologies being investigated which are applicable to strategic missile systems include low cost case and nozzle materials, design methodologies and manufacturing techniques, non-toxic replacement for hydrazine, and low cost, high energy solid propellants.

The first three of the efforts identified in the preceding section dealing with the Strategic Technology IPT Initiatives -- Missile Solid Propulsion, MIRV Deployment and Control Systems, and Solid Rocket Motor Aging and Surveillance -- have been integrated with the IHPRPT program to achieve maximum effectiveness in technology development.

Navy Programs

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NAVY SLBM WARHEAD PROTECTION PROGRAM (SWPP). This is a collaborative Navy/DOE effort to maintain the capability to jointly develop replacement nuclear warheads for the W76/MK4 and W88/MK5 should new warheads be needed in the future. The SWPP provides DOE with the customer interface in order to direct its warhead development capability base investments to requirements generated by the DoD customer. Going beyond technology, it encompasses people, facilities, and the means for generating hardware for operational systems. SWPP is concentrating on two designs, one near-term and the other long-term. Replacement warheads reflect no new weapon requirements but the desirable replacement characteristics include decreased sensitivity to aging, increased design margins, increased ability for surveillance by above-ground testing, and the ability to be certified without an underground nuclear test. SWPP may include flight testing of design elements but does not encompass production. The program has both DOE and DoD components in order to support a fully integrated technical approach.

TRIDENT D-5 BACKFIT PROGRAM. The Trident SSBN force consists of eight submarines equipped with the Trident I (C-4) missile and ten submarines with the Trident II (D-5) missile. The Navy's backfit program will update four of these C-4 platforms to the more modern and longer range D-5 missile. These upgrades begin in FY 2000, and will finish in FY 2006. Under current planning which assumes ratification of START II, the result will be fourteen D-5 Trident SSBNs by FY 2006.

Air Force Programs

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NUCLEAR WEAPONS CAPABILITIES PROTECTION ASSESSMENT (NWCPA). Each of the Air Force Project Officer Groups (POGs) for deployed nuclear weapon types has initiated a NWCPA. These assessments will build a priority list at the subsystem and component level of candidate items for possible replacement.. The NWCPA will also identify design and acceptance criteria for all replacement

parts. This list will then be used to coordinate DOE's Stockpile Life Extension Program to produce replacement parts for the stockpile. In a START II, or beyond, force structure the Air Force is not faced with the same issues as the Navy. Under START II, the Minuteman III fleet can carry either the W78/Mk12A or the W87/Mk21 in a single warhead configuration. The current stockpile has sufficient number of W78/Mk12As and W87/Mk21s to fully load the 500 Minuteman III fleet if a single catastrophic failure should occur in one or the other. A similar condition exists for the gravity bombs. A study is currently underway to determine if any active or inactive warhead can be used to back-up the W80 cruise missile.

BOMBER TECHNOLOGIES. Northrop Grumman will deliver the last Block 30 B-2 Advanced Technology Bomber to the Air Force in 2000. The Block 30 configuration will be fully combat capable, meeting all user requirements including the ability to employ the B61 and B83 nuclear weapons. The Air Force plans to keep the B-52H as a component of the strategic nuclear force through 2040, requiring several modernization and sustaining engineering programs. The programs include navigation, communications, electro-optical viewing, and electronic countermeasure systems improvements. The B-52H is the only bomber aircraft capable of employing the Air Launched Cruise Missile (ALCM) and Advanced Cruise Missile (ACM). The B-1 will be a component of the strategic nuclear force through fiscal year 1997. After 1997, the Air Force plans to dedicate the aircraft to conventional operations. The B-1's conventional capabilities are being enhanced through the Conventional Mission Upgrade Program (CMUP), which includes navigation, communications, advanced conventional weapons, and electronic countermeasures upgrades. The CMUP program started in 1994 and will be completed in 2002. The B-2 Advanced Technology Bomber will be in production through 2004.

The B-1 electronic countermeasures improvements are a conventional bomber modernization program which will contribute to sustaining industrial capabilities that are also important to the survivability of strategic nuclear bombers. This R&D program enters engineering manufacturing and development in 1997 with a projected IOC of 2002.

In 1995, the Heavy Bomber Industrial Capabilities Study concluded that tactical aircraft developments such as the F/A-18 E/F and F-22 will preserve the requisite technical elements of aircraft design and development teams to support a future strategic bomber development program, although nuclear hardness was not considered in this study.

MINUTEMAN III TECHNOLOGIES. Several ICBM modernization programs have been established to sustain Minuteman into the future. The Guidance Replacement Program (GRP) and the Propulsion Replacement Program (PRP) are on-going efforts to correct age-related degradations, improve system reliability and supportability, enhance nuclear surety, and reduce life cycle costs. GRP, which will replace aging guidance system components with modern and supportable electronics, is currently in engineering and manufacturing development. Production begins in 1998 and continues through 2005. PRP remanufactures the three Minuteman booster stages to correct age-related degradations.

Also underway is the ICBM Demonstration and Validation (Dem/Val) Program to evaluate upgrades and emerging technologies and long range planning crucial to maintaining Minuteman on alert. Areas to be investigated include those involving the guidance, propulsion, and reentry systems as well as new forms of survivable communications for the Minuteman Launch Control Centers.

Finally, the Minimum Essential Emergency Communications Network (MEECN) will provide modernized, secure, and survivable communications links between the National Command Authorities (NCA) and the strategic forces. Three projects within this program are under development; DIRECT, MMRT, and EHF. DIRECT, or Defense IEMATS Replacement Command and Control Terminals, transitions the current command and control system from AUTODIN to Defense Message System (DMS). The Modified Miniature Receive Terminal, or MMRT, will provide the ICBM LCCs and airborne command centers with a common, JCS standard High Data Rate (HIDAR) capability for transmitting/receiving NCA directives. The Extremely High Frequency (EHF) project will provide a modernized receive/transmit EHF link from the NCA to the ICBM LCCs.

NUCLEAR EFFECTS PHENOMENOLOGY AND HARDENING TECHNOLOGY

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Status of Requirements

Over a period of 50 years, the Defense Department has developed an understanding of nuclear weapon effects and the physics of weapon effect-target interactions. This understanding provided the technical basis for DoD targeting and survivability activities. Much of this understanding was directly derived from nuclear tests, which provide a broad spectrum of effects. If this understanding were to be lost because the information is not appropriately captured and preserved, in the absence of testing it would not be possible to reconstitute this knowledge base with high confidence in the results.

Without nuclear testing, DoD must rely on simulators which provide verification in narrower segments of the threat spectrum. Sufficient technical progress has been made over a half-century of research and development to allow some, but not all, nuclear weapon effects to be realistically simulated. In some cases, realistic simulation is possible, but only over small areas or volumes, which precludes use of simulators for testing of actual size systems. Effort is ongoing to improve simulation capabilities both with respect to simulation fidelity (the accuracy with which weapon effects are reproduced) and with regard to the size of the objects that can be tested to validate survivability.

Nuclear survivability has high current relevance. For example, it counters the threat that nuclear proliferants might employ small numbers of weapons to produce EMP effects that would damage unprotected U.S. systems. It also responds to the need to hedge against reemergence of peer adversary competition. Nevertheless, some aspects of the Defense Department's understanding of nuclear weapon lethality and survivability do not have high current or anticipated future relevance. For example, if potential antagonists do not base their nuclear systems in superhard silos, special technical capabilities and understanding developed for defeat of such targets need not be actively maintained. However, the required competence must be archived in a manner that provides confidence that the information will be preserved and can be put to use (on a satisfactory reconstitution timeline) if such a requirement to defeat hardened silos develops at some point in the future.

Several dynamics have been given attention in the Defense Department's efforts to develop nuclear weapons effects technologies appropriate for the new nuclear mission. For nuclear delivery systems, much of the task involves preservation of survivability that has already been achieved. These will not be static systems. Over time, key subsystems and components will be modernized or replaced. The impact that such modifications have on system survivability must be appraised. Furthermore, over a longer time horizon there may be a need to give consideration to developing new nuclear delivery systems, with concomitant requirements for system survivability validation.

Even greater dynamics are evident for the conventional systems that must be capable of withstanding threats posed by proliferants during regional contingencies. Many new systems are being introduced. Some of these systems rely on commercial parts and standards, unlike the past when such items were developed through a unique-to-DoD military process that included specification and validation of nuclear hardening requirements. Survivability validation must be adapted to new acquisition practices.

Accomplishing survivability validation for DoD nuclear systems in the absence of underground testing will require the integrated development and utilization of computational physics and simulations, weapon effects simulators (to test systems and validate codes) and the DoD nuclear knowledge base.

Furthermore, some present shortfalls in understanding of nuclear effects, weapon-target interaction, and system survivability must be redressed, and new requirements are likely to occur in the future.

Nuclear Effects, Weapon-Target-Interactions, and Hardening R&D

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Over the course of the transition from the Cold War to the current strategic situation, there has been a significant reduction in DoD investments in nuclear effects, weapon-target-interactions, and hardening research and development. At its Cold War peak, the Defense Nuclear Agency's spending on such R&D was three times greater than the current investment of its successor DSWA in such programs. Obvious issues result, particularly for long-term sustainment of the cadre of technical specialists needed to support DoD Nuclear Weapon Systems Sustainment Programs.

As part of its revised mission, DSWA is tasked to serve as the DoD Center of Excellence for Nuclear and Special Weapons Effects. This tasking encompasses weapons effects information and activities associated with weapon lethality, weapon system operability, test and simulation, and information and computations. In 1996, DSWA conducted a review that developed an initial appraisal of investment planning for such research and development. The review methodology involved a process in which plausible scenarios were developed, scenario-specific requirements for information and capabilities developed through nuclear R&D programs were identified, and options were identified for responding to long-term Defense Department requirements. The scope of the review did not encompass maintenance and assessment of test facilities, computational resources, and the ongoing testable hardware program (see description below, pp. 28-29).

Based on this review, it was concluded that three sets of activities needed to be given consideration:

> SMART SHUTDOWN. If there is unlikely to be a time-urgent requirement for nuclear R&D, or if sufficient time will be available for reconstitution of technical capability, the appropriate actions are to complete ongoing work and archive technology in ways that ensure its preservation and future usability. This involves more than assembly of existing documentation. Key technical data must be reviewed and interpretations developed to support future applications by researchers and engineers who do not have hand-on experience with the information. Experts must be tasked to develop appraisals of, and guides to, the information being preserved. As with base closure, the at first glance paradoxical situation is that, for some period of time, it costs more to shutdown a facility than to continue previous operations.
>
> RESPONSIVE TECH BASE. This involves investments to ensure that the DoD nuclear tech base can respond to anticipated requirements. This requires an active research program that provides a career path for technical personnel. Attempting to maintain a cadre of on-call as-needed experts won't work; such an approach would not retain best-in-world researchers.
>
> REDUCING OPERATIONAL UNCERTAINTIES. In some areas the review identified shortfalls in current understanding, particularly the technical information needed to ensure the viability of the new force structure. The task here is to identify operationally significant uncertainties and develop solutions that reduce such uncertainties to acceptable levels.

The review developed specific recommendations concerning the assignment of nuclear effects R&D to these three categories. For Smart Shutdown, it outlined a program that would be conducted over a period of 4-5 years.

The review recommended that activities in all three categories be managed to promote interactions between, and integration of, activities by experienced senior researchers, other research and development staff, and new trainees. It suggested that a long-term plan providing predictable funding would make an important contribution to achievement of the objectives. Finally, the review strongly encouraged having others (particularly within DoD) replicate the appraisals.

Defense Radiobiological/Biomedical Research

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The Defense Department has unique requirements for research dealing with acute exposure to high levels of radioactive hazards, as might be produced by a proliferant's use of nuclear or radiological

weapons. DoD also has requirements for prediction and mitigation of combined effects, e.g., as might result from proliferant use of both radiological and biological weapons. Research on potential chronic health hazards associated with depleted uranium shrapnel , and development of fieldable biological dosimetry systems are also requirements not met outside of DoD. The Armed Forces Radiobiological Research Institute (AFRRI) under the Uniformed Services University of the Health Sciences responds to these DoD radiological/biomedical research requirements.. This organization has an internationally recognized scientific staff. It also has unique research facilities, e.g., the only dedicated biomedical research reactor in the United States capable of simulating nuclear weapon effects.

Computational and Simulation Programs

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DOE Stockpile Stewardship and Management Program (SSMP) involves development of advanced computational and simulation capabilities to compensate for the termination of nuclear testing. These capabilities will be used to improve understanding of weapon physics, support weapon assessments and certification, support stockpile surveillance, and contribute to design and evaluation of replacement components and systems. This is being accomplished through the Accelerated Strategic Computing Initiative (ASCI), which is programmed to be supported at a significant level ($98M in FY96, increasing to $225M in FY98).

The review that assessed DSWA R&D investments recommended that DSWA continue present interactions with DOE organizations on these matters and take additional actions as opportunities are presented through the development of new computational capabilities in the ASCI program. In particular, it recommended that DSWA take action to ensure the analyses supporting DoD nuclear effects R&D are based on state-of-the-art computational capabilities, both to provide high quality assessments and to provide the basis needed to support DoD interactions with DOE stockpile stewardship efforts.

Weapon Effects Simulator

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Recent efforts have focused on reducing excess capacity while upgrading capability. At the end of the Cold War, there were more simulator facilities based on then-current simulator technology than required to meet requirements. At the same time, there were shortfalls in simulator capability with respect to the fidelity with which effects can be simulated and with regard to the size of objects that could be tested.

DSWA has developed an X-Ray Simulator Program plan based on user-driven requirements that, where reasonable, closes excess capacity. Four major geographic DoD radiation simulator centers have been reduced to two, with further consolidation planned. The target is development of a state-of-the-art suite of effects simulators at Arnold Engineering Development Center (AEDC). This will include DECADE, which will be the most capable simulator in the world for high energy x-ray effects testing to validate the reliable operations of military systems in nuclear environments.

The Department of Energy has an ambitious simulator development effort underway to support research and development dealing with nuclear device physics. DSWA is closely tracking these DOE programs. Opportunities for DoD add-ons to these facilities that would make them also responsive to DoD effects simulation requirements are being explored with the Department of Energy weapon laboratories.

DSWA nuclear effects simulator program is flexible and responsive to Service requirements. Improvements in simulator capabilities and facilities are guided by requests from the Services and other DoD customers. For example, in response to a Navy request, DSWA is in the process of reactivating a magnetic flyer plate test facility to add to capability to support reentry body survivability testing.

Additional Initiatives

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APPROACH. Developing improved capabilities for physical simulation of nuclear weapons effects is necessary, but not sufficient. Complementary actions have been undertaken to develop the technologies needed for providing DoD systems with protection against weapon effects, and for validation of such protection.

INTEGRATED HARDENING METHODOLOGIES. More affordable approaches to hardening electronics against both nuclear and non-nuclear electromagnetic hazards are needed. This new program, which has been approved by DDR&E as a Defense Technology Objective, is developing and validating such methodologies. Initial emphasis is being given to combined protection against both electromagnetic pulse (EMP) and High Power Microwave (HPM) threats.

TESTABLE HARDWARE. This DSWA program documents design and test protocols that simplify hardening and reduce the cost of hardness verification testing, providing an efficient methodology for balancing the various methods of hardening. The protocols, which are a formal sequence of design practices, are based on past hardening experience from across the acquisition community, both government and contractor, as well as new techniques applicable to today's evolving technology. Design and test protocol programs are already in progress in the areas of spacecraft, missile, interceptor and sensor systems at radiation threat levels reflective of today's reduced survivability requirements. Future efforts in the Testable Hardware Technology program will include extending the applicability of the existing protocols in regions of more intense weapons effects. These future protocols would be applicable to the survivability requirements, technology and test capability needed for ballistic missile reentry vehicles and post-boost vehicle systems.

PRESERVATION AND APPLICATION OF THE DEFENSE DEPARTMENT'S NUCLEAR WEAPON EFFECTS KNOWLEDGE

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Since the conclusion of atmospheric nuclear testing in the early 1960s, DSWA has been responsible for safeguarding the data and analytical products developed in DoD nuclear tests and other DoD technical nuclear programs. Until recently, much of this task was accomplished through DSWA sponsorship of the DoD Nuclear Information Analysis Center (DASIAC). For most of the period since DASIAC's establishment, DoD requirements for this unique information were met by preserving copies of the original documentation, such as paper reports and magnetic media on which data were recorded. This historical understanding of nuclear weapon effects could be (and was) supplemented by the ongoing underground nuclear test program.

Coincident with the termination of underground nuclear effects testing, an additional program -- Data Analysis and Retrieval Enhancement (DARE) -- was initiated. This program will be critical for the successful implementation of Smart Shutdown in selected areas of DoD nuclear research and development.

DARE uses state-of-the-art electronic digitization and long-life optical media to ensure long-term preservation of the unique and irreplaceable technical records developed over the past half-century in DoD nuclear programs. The information in report form alone exceeds 12 million pages.

In 1993, DSWA initiated a "Graybeard Project" to critically review and evaluate the technical information documenting DoD nuclear test and simulation programs. The Graybeards are experts who have a unique understanding of the nuclear test database, e.g., former technical directors of atmospheric and underground tests.

Ensuring long-term preservation of the effects testing record is a necessary but not sufficient action for responding to the Defense Department's long-term requirements for this information. DSWA publishes

authoritative references in both report and automated formats to ensure this information is available for application. Examples include EM-1, the authoritative reference manual for nuclear weapon effects information, and the recently published Handbook of Nuclear Weapon Effects.

Important data archiving programs are also being accomplished with the military departments. For example, the Navy has developed a repository for the W88 warhead/Mark 5 reentry body used by the Trident D-5 Submarine-Launched Ballistic Missile.

Consideration is being given to the pace of data archiving efforts within DoD, given the unavoidable reality that this is the last opportunity for participation by experts who have personal involvement in nuclear test activities. As progress is made in the assembly of archives, more attention will be given to exercises to establish and enhance the usability of the information.

Through the Alliance program described previously, DSWA and other DoD organizations are coordinating with counterparts within DOE and DOE-sponsored organizations on nuclear-weapons-related matters of common interest. Data archiving activities are one of the topics addressed. As progress is made in programs within both departments, opportunities for additional levels and forms of cooperation may be identified.

CONCLUSIONS

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There has been significant progress in the Defense Department's nuclear weapon systems programs. New strategic requirements have been defined. A force structure appropriate to these needs has been configured. There has been progress in developing the DoD Nuclear Weapon Systems Sustainment Programs needed for both current and longer-term support of this force structure.

Oversight procedures and organizational missions have been reviewed. Adjustments have been made to the charters of the Office of the Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs) and the Defense Special Weapons Agency that provide improved responsiveness to Nuclear Weapon Systems Sustainment Programs and other current nuclear missions.

The Defense Department has a half century of experience accomplishing sustainment of nuclear capabilities. This history has been reviewed to identify the critical characteristics needed for success.

Priority has been given to ensuring that the required numbers of personnel with appropriate qualifications are available to support sustainment activities. It is particularly important to develop and maintain career paths so that new personnel can be trained and are available in the future. This has necessitated more active surveillance and management of the cadres of personnel who support Nuclear Weapon Systems Sustainment Programs. Additional initiatives to sustain these cadres will be taken as issues are better defined.

Weapon system hardware technology is also critical. Both OSD and the Services have taken steps to sustain deployed systems. As modifications are inevitably made, additional actions will be taken to guarantee we can have warranted confidence in the effectiveness and survivability of these systems.

The first steps have been taken in a comprehensive appraisal of nuclear effects phenomenology and hardening technology capabilities. Follow-up actions will establish appropriate focuses and levels of investment for a mix of activities involving selected smart shutdowns, maintenance of a responsive tech base, and research to reduce operational uncertainties.

A roadmap for development and reconfiguration of DoD weapon effects simulators has been developed. This plan will be reviewed and, as appropriate, revised to ensure it corresponds to department-wide Nuclear Weapon Systems Sustainment requirements. State-of-the-art analytical and computational

capabilities to support DoD nuclear requirements will be developed and maintained.

Preservation and application of the unique understanding of nuclear weapon effects developed in past DoD nuclear programs is critical. The pace at which this is accomplished is under continuing review, with emphasis on the need to support selected smart shutdowns and the reality that some expertise will, in a very few years, no longer be available to support review of the database.

Closer cooperation with the Department of Energy on matters involving sustainment of national nuclear capabilities is imperative. As DOE relies on advanced computational techniques and new technical facilities to accomplish its portion of the sustainment mission, DoD will ensure that it develops the capabilities needed to be an effective partner.

The Defense Department's Nuclear Weapons Systems Sustainment Programs provide critical underpinning for deterrence. These programs will be adapted as experience is gained and progress is made in counterpart Department of Energy activities.

Senior DoD leadership will ensure that these programs receive the priority needed to achieve appropriate levels of integration within and across DoD sustainment activities and, most critically, provide a full response to the needs of the operational forces.

ANNEX A

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OVERVIEW OF RELATED SUSTAINMENT ACTIVITIES BEING ACCOMPLISHED BY THE DEPARTMENT OF ENERGY

Cooperation between the Department of Defense and the Energy Department is essential for sustainment of national nuclear capabilities. Two developments -- the end of nuclear testing and the fact that no new nuclear weapon systems are under development -- have had a major impact on the DOE program. Completely new approaches for accomplishment of the DOE portions of the stewardship mission have been developed for reasons outlined in Figure A-1.

Figure A-1

Past Approaches to Maintaining Stockpile Confidence

The U.S. nuclear weapons stockpile is currently judged to be safe, secure, and reliable. However, decades of experience with the stockpile has often revealed the need for repair or replacement of components and subsystems. Of the weapon systems introduced into the stockpile since 1970, nearly half have required post-development nuclear testing to verify, resolve, or fix problems relating to safety or reliability. Of the seven systems that are candidates for the enduring stockpile, all seven have already been retrofitted to some degree, including the replacement of major nuclear components in some cases.

The average age of the stockpile has never exceeded the current average age of 12 to 13 years. Although we cannot predict with certainty when age-related changes affecting weapon safety or reliability will occur, we must anticipate they will arise more frequently as the weapons retained in the enduring stockpile age to and beyond their original 20- to 25-year design lifetimes...

In the past, an often renewed and diverse stockpile provided "insurance" against single-point and common-mode failures (i.e., failures or defects compromising the safety or reliability of, respectively, a single weapon system or several systems sharing a common design feature). Nuclear testing could be done to provide unambiguous verification of the effects of design features, material changes, or safety issues that could not be adequately calculated or tested in other ways. Continuous development and production of new weapon systems not only provided the U.S. stockpile with the most modern and effective weapons but also maintained the technical competence of the laboratory and production complex in the science and engineering of nuclear weapons. In addition, a steady supply of tritium was provided to support new weapons and to replenish the inventory reduction caused by radioactive delay of the tritium in existing weapons.

Today, none of these conditions exist. Thus it is essential that we develop new strategies and approaches to ensure the safety, reliability, and performance of the stockpile (and confidence in our ability to do so) under current conditions -- namely, no nuclear testing or production.

Excerpted from The Stockpile Stewardship and Management Program
U.S. Department of Energy, Office of Defense Programs, May 1995
http://www.dp.doe.gov/projini.htm

The new strategy adopted by DOE involves development and implementation of a Stockpile Stewardship and Management Program, key elements of which are presented in Figure A-2.

Figure A-2

DOE Stockpile Stewardship and Management Program

Maintaining Confidence in Stockpile Safety and Reliability without Nuclear Testing

- Existing nuclear test data is insufficient for assessing and maintaining confidence in the safety and performance of the stockpile weapons over extended outyears or in cases where changes have been made.
- Enhanced experimental and computational capabilities will be developed, with particular emphasis given to redressing shortfalls in physics understanding and data needed for computational simulations of weapon performance and weapon safety and reliability assessments.
- This requires establishment of an improved science-based program; this program must be technically challenging so that it will attract the high quality scientific and technical talent needed for future stockpile stewardship.
- Thrusts here include the Accelerated Strategic Computing Initiative (ASCI) to support significant improvements in computational and simulation capabilities and development of new

experimental and surveillance facilities.

Reducing the Vulnerability of the Smaller Stockpile to Single-Point and Common-Mode Failures

- A larger stockpile with over 20,000 weapons and more than 25 weapons types, provided substantial protection against such failures. Vulnerabilities increase with the transition to a smaller enduring stockpile with fewer than 5,000 weapons and 7 weapon systems.
- Enhanced weapons and materials surveillance technologies programs are being established to detect potential problems earlier and lessen the enduring stockpile's vulnerabilities to both single-point and common-mode failures.

Providing an Effective and Efficient Production Complex for the Smaller Stockpile

- Advanced manufacturing and materials technologies must be developed to provide timely and flexible response to correcting stockpile problems. Research, development, and manufacturing must be highly integrated.
- The capacity-based production infrastructure of the past, configured for continuous upgrading of a relatively large stockpile, must be replaced by a smaller, more efficient capability-based complex supported by improved scientific understanding of nuclear weapons and their production processes.

Providing for Long-Range Support of the Enduring Stockpile

- In the past, continuous development and production of new weapons maintained the scientific and technical knowledge and skills base. Absent action, the knowledge and skills base unique to nuclear weapons will atrophy.
- Existing surveillance programs that remove weapons from the stockpile for evaluation will continue.
- The improved predictive capabilities being developed in other portions of the program will be applied.
- Safety and design margins will be increased.
- Corrective maintenance and system replacement will be accomplished.

Ensuring an Adequate Supply of Tritium

- All of the weapons being considered for the enduring stockpile require tritium replenishment.
- A strategy has been developed for bringing new production capability on-line.

Source:
The Stockpile Stewardship and Management Program,
U.S. Department of Energy, Office of Defense Programs, May 1995
http://www.dp.doe.gov/projini.htm

As explained in the body of this report, DoD and DOE activities must be coordinated to ensure stewardship of national nuclear competencies. To this end, DoD programs can and will be adapted to provide the required interface with DOE programs.

A more detailed summary of DOE nuclear weapon sustainment activities is provided by DOE/Defense Programs in The Stockpile Stewardship and Management Program, available on the Internet at http://www.dp.doe.gov/projini.htm.

ANNEX B

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OVERSIGHT AUTHORITIES AND ORGANIZATIONS INVOLVED IN NUCLEAR WEAPON SYSTEMS SUSTAINMENT PROGRAMS

INTRODUCTION

This annex provides additional information concerning the DoD and interagency organizations, mechanisms, and officials whose activities are described in this report.

Defense Department Officials and Organizations

ASSISTANT TO THE SECRETARY OF DEFENSE (NUCLEAR AND CHEMICAL AND BIOLOGICAL DEFENSE PROGRAMS), ATSD(NCB). The ATSD(NCB) is the principal staff assistant to the Secretary of Defense for nuclear-weapons-related matters. ATSD(NCB) also is the DoD lead for coordination with DOE concerning nuclear-weapons-related matters.

UNDER SECRETARY OF DEFENSE (ACQUISITION & TECHNOLOGY),(USD(A&T)). USD(A&T) has oversight responsibility for all DoD research, development, test, evaluation, and acquisition programs.

DIRECTOR, DEFENSE RESEARCH & ENGINEERING,(DDR&E). DDR&E exercises oversight for all DoD science and technology (S&T) programs, including those directed at nuclear weapon systems requirements. DDR&E develops the Defense S&T Strategy and supervises the definition of Defense Technology Objectives for DoD S&T. As part of this process, DDR&E conducts an annual Technology Area Review Assessment that encompasses nuclear mission S&T.

Director, Strategic and Tactical Systems (D/S&TS). D/S&TS is the OUSD(A&T) official responsible for oversight of strategic delivery system acquisition activities.

CHAIRMAN, JOINT CHIEFS OF STAFF (CJCS). The Chairman is the senior uniformed military authority responsible for requirements for nuclear weapon system and other defense capabilities. The Chairman is responsible for coordinating the requirements developed by the Commanders of the Unified Commands.

COMMANDERS OF THE UNIFIED COMMANDS (CINCs). The Unified Commands are Joint organizations responsible for planning and executing military operations.

Commander, U.S. Strategic Command. As the commanding officer responsible for the preponderance of deployed nuclear forces, CINC U.S. Strategic Command has special responsibilities and activities relevant to Nuclear Weapon Systems Sustainment Programs.

- The U.S. Strategic Command's staff coordinates with the supporting Services in monitoring the day-to-day status of the stockpile.
- Weapon system specialists are assigned to the Project Officer Groups (POGs) for each weapon type. The POGs are responsible for monitoring the state of the stockpile and submitting recommendations for improving stockpile safety, reliability or security to the Nuclear Weapons Council (NWC) Standing and Safety Committee.
- U.S. Strategic Command sponsors a senior-level Strategic Advisory Group responsible for providing assessments of current and future issues related to the nuclear stockpile and associated systems.
- Safeguard F of the President's 11 August 1995 Comprehensive Test Ban Treaty (CTBT) policy statement directs annual assessments of the nuclear weapons stockpile. The primary assessment is developed through the Nuclear Weapons Council process. In addition to contributing to this NWC process appraisal, the Commander of the U.S. Strategic Command provides an independent assessment covering the same topics to the Secretary of Defense.

MILITARY DEPARTMENTS AND DEFENSE AGENCIES. In accordance with customary Defense Department management practices, officials within the Office of the Secretary of Defense establish guidance and exercise oversight, while program execution is accomplished by the Military Departments and the Defense Agencies.

Navy. The Navy operates Submarine-Launched Ballistic Missiles carried by Fleet Ballistic Missile submarines. It also maintains the capability to redeploy nuclear-armed Tomahawk Land-Attack Missiles (TLAM/N) to the attack submarine fleet.

The Navy has retained its Strategic Systems Programs (SSP) command which has cradle to grave responsibility for all Navy strategic nuclear weapon systems. It will continue the production of D5 missiles through the year 2006. A follow-on Submarine Launched Ballistic Missile (SLBM) is intended, but no funding or specific plans have been established. The Tomahawk Land-Attack Missile/Nuclear (TLAM/N), a non-strategic weapon, is the responsibility of the PEO Cruise Missiles and Joint Unmanned Aerial Vehicles.

Project Officer Groups (POGs) continue to operate for the weapons carried on Navy delivery systems. These POGs are the day to day technical interface between the Navy (including operational units) and DOE for the sustainment of nuclear capable systems and associated warheads.

SSP has established a Propulsion Consolidation Program which is moving the production of all missile stages into a small number of manufacturers. The goal is to keep a talented pool of propulsion experts. Additional Navy programs directed at nuclear weapon systems sustainment are described in other sections of this report.

Air Force. Bombers, Intercontinental Ballistic Missiles (ICBM) and dual-capable tactical aircraft are the Air Force's primary contributions to the nuclear force structure.

On 1 January 1997, the Directorate for Nuclear and Counter-proliferation (AF/XON) was established within Headquarters Air Force, under the Deputy Chief of Staff for Air & Space Operations. The AF/XON, headed by a Major General, is the single accountable point of contact for system wide performance of the Air Force's nuclear deterrent forces. As such, the AF/XON is the Air Force's representative to the Nuclear Weapons Council Standing and Safety Committee, where nuclear weapons matters are addressed. As with the Navy, POGs have been continued for all nuclear weapons carried by Air Force systems that are to be retained in the enduring force strategic force structure.

The Air Force Ballistic Missile Office (BMO) and its successor, Detachment-10, have been closed and the strategic system functions transferred to the ICBM System Program Office at Hill Air Force Base (AFB). As part of the Defense Department-wide base realignment and closure process, nuclear mission-related functions previously accomplished at Kelly Air Force Base are being relocated to the Air Force Center of Excellence at Kirtland Air Force Base. ICBM recovery vehicle support will be assigned to the ICBM SPO. Aircraft, cruise missile, and support equipment sustainment activities will be assigned to the respective system program offices at Hill AFB, Tinker AFB, and Robbins AFB.

Army. The Army no longer has nuclear delivery systems. This has allowed it to close its Program Management Office for Nuclear Munitions (PM-Nuc). Notwithstanding the end of its delivery missions, the Army is actively involved in nuclear Joint programs, e.g., preparation of the Joint manuals for targeting. The Army also develops doctrine for support of land force operations by nuclear systems operated by other Services. A formal process continues defining survivability requirements for land combat systems.

Ballistic Missile Defense Organization (BMDO). Threats involving the delivery of nuclear, radiological, chemical, or biological munitions by ballistic or cruise missiles are the primary reason why increased emphasis has been given to both theater and national missile defenses.
The development programs managed by BMDO involve non-nuclear mechanisms for defeat of missile threats. The need for these defensive systems to have the levels of nuclear survivability needed for

accomplishment of their missions in a nuclear threat environment is one of the factors given considerations in these programs.

Defense Special Weapons Agency(DSWA). DSWA serves as the lead DoD agency for nuclear stockpile stewardship programs. Relevant activities include supporting DoD dual-revalidation, annual certification and other stockpile stewardship functions; maintaining the nuclear stockpile database; maintaining weapons effects and test data as well as simulation and simulator capability, acting as the Chairman, JCS agent for weapons technical inspections; providing logistics support for DoD nuclear weapons; contributing to emergency response support; supporting military education and operational training programs; and developing and applying advanced methodologies to evaluate and enhance the safety of DoD nuclear weapon systems

Mechanisms for DoD-DOE Coordination

NUCLEAR WEAPONS COUNCIL (NWC). The NWC is the senior management body for nuclear weapons-related matters involving DoD and DOE. Members are the Under Secretary of Defense (Acquisition & Technology); Vice Chairman, Joint Chiefs of Staff; and a senior representative appointed by the Secretary of Energy. ATSD(NCB) serves as Staff Director.

One of the NWC's responsibilities is to provide an annual stockpile assessment to the Secretary of Defense and the Secretary of Energy under Safeguard F of the President's 11 August 1995 Comprehensive Test Ban Treaty (CTBT) policy statement. The data collection process behind this assessment provides a detailed look at current and future stockpile issues which may impact the warhead, its delivery vehicle, and other parts of the weapon system support structure. As part of this process, the Commander of the U.S. Strategic Command and the heads of the three DOE nuclear weapon laboratories (Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), and Sandia National Laboratories (SNL)) submit concurrent independent assessments addressing the same topics.

NUCLEAR WEAPONS COUNCIL STANDING AND SAFETY COMMITTEE (NWCSSC) and NUCLEAR WEAPONS REQUIREMENTS WORKING GROUP (NWRWG). The NWCSSC, chaired by the ATSD(NCB) is the NWC agent for accomplishing DoD/DOE coordination actions involving nuclear weapons matters. The NWC/NWCSSC process is the primary mechanism for inter-department coordination on sustainment. The NWRWG is a general officer level group, chaired by the Principal Deputy Assistant Secretary for Defense Programs (DOE), established to supplement the NWCSSC; it provides additional senior level guidance on nuclear weapon requirements to the NWCSSC.

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GLOSSARY FOR SELECTED TERMS

Accelerated Strategic Computing Initiative (ASCI) - Department of Energy initiative to develop new, best in world, computational capabilities to support stockpile stewardship; see Annex A.

Data Analysis and Retrieval Enhancement (DARE) - Data Analysis and Retrieval Enhancement (DARE) - A DSWA program that uses state-of-the-art electronic digitization and optical storage media to ensure long term preservation of nuclear program records and documentation.

Defense Technology Objectives (DTO) - A set of approved DoD science and technology objectives developed in the Defense Science and Technology program conducted under the oversight of Director, Defense Research and Engineering.

Depleted uranium - Uranium in which the natural concentration of the fissile isotope U235 has been reduced.

Dual-revalidation - Process by which each nuclear warhead is recertified as safe, secure, and reliable by a fresh, clean analysis (to include some component testing) by both the original designing lab and an independent effort by the other design lab.

Dual-use technology - technology having both legitimate civilian and military uses.

Electromagnetic Pulse (EMP) - A sharp pulse of radio-frequency (long wavelength) electromagnetic radiation is produced when a nuclear explosion occurs in an unsymmetrical environment, especially at or near the earth's surface or at high altitudes. The intense electric and magnetic fields can damage unprotected electrical and electronic equipment over a large area.

Elastomeric -- materials that, if deformed, can resume their previous shape; rubber is elastomeric.

Environmental remediation - removing or reducing materials, processes, structures, or other human impacts on an area to return it to a more "natural" state.

Hardened Silo - a structure in which a missile is located that has been constructed to provide protection against potential attacks.

Hardness - The degree of resistance of a weapon or its components to adverse environments, particularly the effects of a defensive nuclear burst.

High Altitude Electromagnetic Pulse (HEMP) - the electromagnetic energy produced by a nuclear weapon detonated at a high altitude.

High Power Microwave (HPM) - microwave energy at power levels that allow it to be used as a weapon.

Hydrodynamic tests - Tests of materials at high temperatures and pressures.

Intercontinental ballistic missile (ICBM) - a ballistic missile with a range capability from about 3,000 to 8,000 nautical miles.

IOC - Initial Operating Capability

Joint Nuclear Accident Coordination Center (JNACC) - The DoD and DOE operate coordinating centers for exchanging and maintaining information about radiological assistance capabilities and activities. These centers are separated geographically, but linked by direct communications networks.

Magnetic Flyer Plate - A DSWA facility that uses the opposing magnetic force between two conductive sheets pulsed with a large current to drive one of them against the surface of an object to be tested; this provides a simulation of some of the nuclear weapon effects that might impact a reentry body.

Open Architecture - A computer science term referencing the use of public (non-proprietary) standards.

Physics package - The nuclear explosive part of a warhead developed by one of the design labs, LANL or LLNL, consisting of the Special Nuclear Materials involved and the associated high explosive.

Pit - The fissile metal center of a nuclear weapon that is driven into a supercritical configuration yielding a large release of fission energy.

Project Officer Group (POG) - A group of Department of Energy-Department of Defense (DOE-DoD) personnel assigned to coordinate the development and compatibility assurance of a designated nuclear weapon system and its associated interfaces.

Radiological weapon - a weapon designed to carry and release radioactive contamination, without a nuclear explosion; for example, conventional high explosives might be employed to distribute

radioactive material.

Surveillance - A systematic watch of ammunition or critical components in use or in storage, to include disassembly, examination, and testing of sample lots, to ensure product safety and reliability.

Testable hardware - A DSWA program to document design and test protocols that simplify hardening and reduce the cost of hardness verification testing.

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ACRONYMS

ABNCP	Airborne National Command Post
AEDC	Arnold Engineering Development Center
AFIT	Air Force Institute of Technology
AFRRI	Armed Force Radiobiological Research Institute
AFTAC	Air Force Technical Applications Center
AF/XON	Air Force Directorate for Nuclear and Counter-proliferation
ASCI	Accelerated Scientific Computing Initiative
ASI	Additional Skills Indicator
ATSD(NCB)	Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense Programs
BMDO	Ballistic Missile Defense Organization
BMO	Air Force Ballistic Missile Office
CJCS	Chairman, Joint Chiefs of Staff
CINC	Commander in Chief of a Unified Command
CTBT	Comprehensive Test Ban Treaty
DARE	Data Analysis and Retrieval Enhancement
DASIAC	DoD Nuclear Information Analysis Center
DDR&E	Director, Defense Research and Engineering
DNWS	Defense Nuclear Weapons School
DoD	Department of Defense
DOE	Department of Energy
D/S&TS	Director, Strategic and Tactical Systems
DSWA	Defense Special Weapons Agency
DTO	Defense Technology Objectives
EM-1	Handbook of Nuclear Weapons Effects
EMP	Electromagnetic Pulse
EOD	Explosives Ordnance Disposal
GRP	Guidance Replacement Program
HEMP	High Altitude Electromagnetic Pulse
HPM	High Power Microwave
ICBM	Intercontinental Ballistic Missile
IHPRPT	Integrated High Payoff Rocket Propulsion Technology
IPT	Integrated Product Team
LANL	Los Alamos National Laboratory
LCC	Land Component Commander

LLNL	Lawrence Livermore National Laboratory
MCCC	Mobile Consolidated Command Center
MIL-SPEC	Military Specification
MIRV	Multiple, Independently-Targeted Reentry Vehicle
NATO	North Atlantic Treaty Organization
NEAT	Nuclear Employment Augmentation Teams
NPG	Naval Postgraduate School
NPR	Nuclear Posture Review
NWC	Nuclear Weapons Council
NWCPA	Nuclear Weapons Capabilities Protection Assessment
NWCSSC	Nuclear Weapons Council Standing and Safety Committee
NWRT	Nuclear Weapons Related Technologies
NWRWG	Nuclear Weapons Requirements Working Group
O&M	Operations and Maintenance
OSD	Office of the Secretary of Defense
PBCS	Post Boost Control System
PM-Nuc	Army Program Management Office for Nuclear Munitions
POG	Project Officer Group
POM	Program Objectives Memorandum
PRP	Propulsion Replacement Program
RSAP	Reentry Systems Applications Program
R&D	Research and Development
SAG	Strategic Advisory Group
SLBM	Submarine Launched Ballistic Missile
SNL	Sandia National Laboratory
SSBN	Nuclear-powered ballistic missile-armed submarine
S&T	Science and Technology
SSMP	Stockpile Stewardship and Management Program
SSP	Strategic Systems Program
START	Strategic Arms Reduction Treaty
SWFLANT	Special Weapons Facility Atlantic
SWFPAC	Special Weapons Facility Pacific
SWPP	SLBM Warhead Protection Program
TLAM	Tomahawk Land-Attack Missile
USANCA	United States Army Nuclear and Chemical Agency
USD(A&T)	Under Secretary of Defense for Acquisition and Technology
USSPACECOM	United States Space Command
USSTRATCOM	United States Strategic Command
WMD	Weapons of Mass Destruction

FOOTNOTES:

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*A National Security Strategy of Engagement and Enlargement. The White House, February 1996, pp.

19-21.(return)

**SASC Report 104-267.(return)(return)

***HNSC Report 104-563.(return)

**** The Defense Department has additional nuclear missions not addressed in this report.(return)
